

CLAIMS

1. A sealing device for providing a seal about a shaft that extends between first and second zones where a pressure differential exists between the first and second zones, the sealing device comprising:

- 5 a shaft seal having a sealing portion and a support portion, the sealing portion constructed and arranged to sealingly engage with a shaft and allow the shaft to be at least one of slidingly and rotationally moved relative to the sealing portion; and  
a seal mount having a first end, a second end and a flexible member between the first and second ends that enables movement of the first end relative to the second end in  
10 at least one degree of freedom, the first end being sealingly engageable to at least a portion of the support portion of the shaft seal, the second end being sealingly engageable to an engagement surface about a port into a process chamber.

- 15 2. The sealing device of claim 1, wherein the flexible member defines a transition space in the first zone, the transition space being in fluid communication with the process chamber.

- 20 3. The sealing device of claim 1, wherein the port comprises a central axis, the flexible member allowing movement of the shaft seal in at least two degrees of freedom relative to the central axis of the port.

4. The sealing device of claim 1, wherein the port further comprises a port size and a portion of the shaft extending through the port has a shaft size, the port size being substantially larger than the shaft size.

- 25 5. The sealing device of claim 1, wherein the port comprises a central axis, and the shaft seal is movable to allow the shaft to be angularly offset relative to the central axis of the port.

6. The sealing device of claim 1, wherein the port comprises a central axis, and the shaft seal is movable to allow the shaft to be laterally offset relative to the central axis of the port.

5 7. The sealing device of claim 1, wherein the sealing portion of the shaft seal sealingly engages with a cylindrically-shaped portion of the shaft.

10 8. The sealing device of claim 1, wherein the sealing portion sealingly engages the shaft so that the shaft may be both slidingly and rotationally moved relative to the sealing portion.

9. The sealing device of claim 1, wherein the sealing portion sealingly engages the shaft so that the shaft may be rotationally moved, but not slidingly moved, relative to the sealing portion.

15 10. The sealing device of claim 1, wherein the support portion includes a housing having a shaft bore with an inner surface, the shaft bore constructed and arranged to allow the shaft to pass through the shaft bore.

20 11. The sealing device of claim 1, wherein the support portion of the shaft seal is characterized as being substantially rigid.

25 12. The sealing device of claim 11, wherein the shaft seal includes a portion constructed from at least one member of the group consisting of metals, powder metals, ceramics, metallo-ceramics, rigid plastics, and combinations thereof.

13. The sealing device of claim 1, wherein the flexible member includes at least one of natural rubber, silicone rubber, and elastomeric polymer materials.

30 14. The sealing device of claim 1, wherein the flexible member includes a plurality of undulations.

15. The sealing device of claim 1, wherein the flexible member includes a bellows portion.

5 16. The sealing device of claim 1, further comprising a first retaining ring constructed and arranged to sealingly engage a first end of the flexible member to the shaft seal.

10 17. The sealing device of claim 16, further comprising a first O-ring positioned between the first retaining ring and the shaft seal.

15 18. The sealing device of claim 1, further comprising a second retaining ring constructed and arranged to sealingly engage a second end of the flexible member to an engagement surface of the process chamber.

19. The sealing device of claim 18, further comprising a second O-ring positioned between the second retaining ring and the engagement surface.

20. The sealing device of claim 1, wherein the flexible member includes a flexible collar.

21. The sealing device of claim 20, wherein the shaft is moveable in a reciprocating manner relative to the shaft seal and the port.

25 22. The sealing device of claim 20, wherein the shaft is moveable in a rotating manner relative to the shaft seal and the port.

23. The sealing device of claim 1, wherein the sealing member comprises: a first seal member, a second seal member, and a spacer seal member positioned 30 therebetween, each of the seal members having a first surface and a second surface, the

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first surface being supported by the support portion and the second surface being sealingly associated with the shaft.

24. The sealing device of claim 23, further comprising a differential space  
5 between the first and second seal members, the differential space being fluidly connectable with a vacuum source.

25. The sealing device of claim 24, wherein the differential space is located  
between the spacer seal member and the support portion.

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26. The sealing device of claim 25, wherein the seal mount defines a transition space in the first zone, and the differential space is fluidly connectable to the transition space.

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27. A floating shaft seal for providing a vacuum seal about a reciprocating and/or rotating shaft, wherein the shaft is passed from a zone at ambient air pressure through an opening in a chamber, the chamber having a substantially lower pressure than ambient, the floating shaft seal comprising:

- 20 a sealing member constructed and arranged to sealingly engage with a shaft and allow the shaft to move relative to at least a portion of the sealing member; and  
a flexible mounting collar having a first end opening and a second end opening, the first end opening being sealingly engageable with the sealing member, the second end opening sealingly engageable about the opening in the chamber.

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28. The shaft seal of claim 27, wherein the opening in the chamber has a central axis, and the sealing member and flexible mounting collar are constructed and arranged to allow the shaft to be offset relative to the central axis.

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29. The shaft seal of claim 28, wherein the sealing member and the flexible mounting collar are constructed and arranged to allow the shaft to be rotated about an axis transverse to the central axis.

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30. The shaft seal of claim 27, wherein the sealing member is constructed and arranged to allow the shaft to rotate relative to at least a portion of the sealing member.

5 31. The shaft seal of claim 27, wherein the sealing member is constructed and arranged to allow the shaft to slide along a longitudinal axis of the shaft relative to at least a portion of the sealing member.

10 32. The shaft seal of claim 27, wherein a portion of the sealing member sealingly engages with a cylindrical portion of the shaft.

33. A device for maintaining a seal about a mobile shaft that extends from a first chamber into a second chamber, the first chamber having a first pressure, the second chamber having a second pressure, the device comprising:

15 an inner housing having an inside surface and an outside surface, the inside surface defining a substantially cylindrical passage, a first portion of the substantially cylindrical passage having a first diameter sized to allow passage of the shaft therethrough;

20 a seal member positioned therebetween, each of the seal members having a first surface and a second surface, the first surface being supported by the first portion of the substantially cylindrical passage, the second surface being sealingly engaged with the shaft; and

25 an outer housing comprising a flexible member and having a first end and a second end, the first end sealingly engaged to a portion of the outside surface of the inner housing, the second end sealingly engaged to a wall of the second chamber, the outer housing flexibly supporting the inner housing so the inner housing is moveable relative to the wall of the second chamber.

34. The device of claim 33, further comprising:
- a differential space between the first surface of the spacer seal member and the first portion of the substantially cylindrical passage; and
  - a differential pumping line in fluid communication with the differential space, the differential pumping line extending from the differential space through the inner housing.

- 5      35. An ion beam measuring device comprising:
- a vacuum chamber having an inside and an outside, the vacuum chamber being defined by a plurality of walls and housing an ion beam projected from a beam source, one of the plurality of walls having an opening;
  - 10      a shaft having a first end and a second end, the shaft passing through the opening in one of the plurality of walls in the vacuum chamber;
  - 15      a measuring device operatively engaged to the first end of the shaft;
  - 15      a control unit positioned on the outside of the vacuum chamber and engaged with the second end of the shaft; and
  - 20      a seal device mounted adjacently to a wall of the vacuum chamber, the seal device having a flexible member and sealingly engaging the shaft so the shaft is free to at least one of rotate and slide relative to the seal device, the seal device being sealingly engaged about the opening in one of the plurality of walls and resisting fluid flow from outside the vacuum chamber through the opening in one of the plurality of walls, the flexible member allowing the shaft to be offset relative to the opening in one of the plurality of walls while sealing engagement is substantially maintained with the shaft.